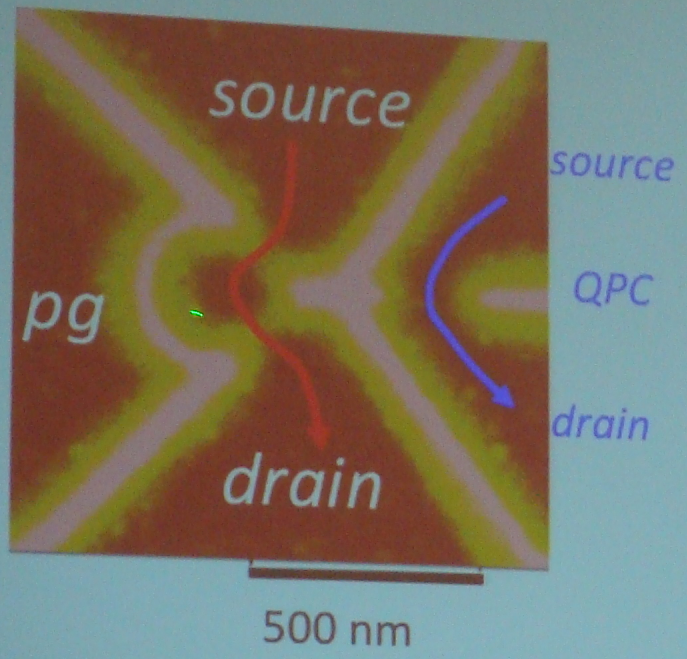
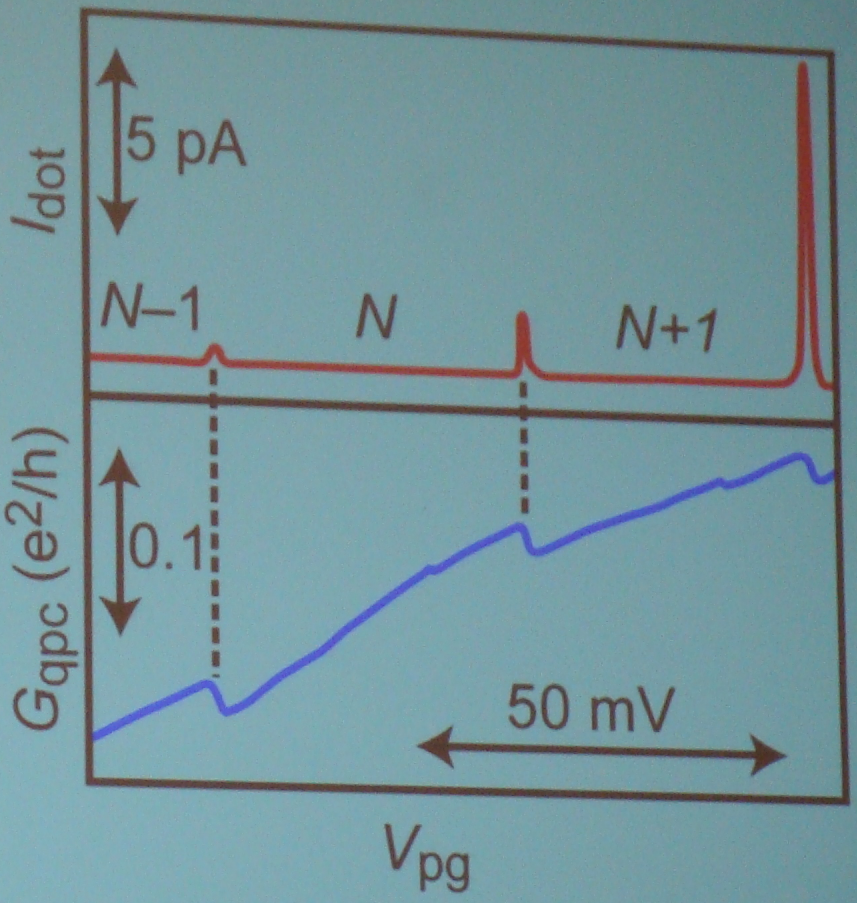
Charge detection: an implementation

Ga[Al]As heterostructure

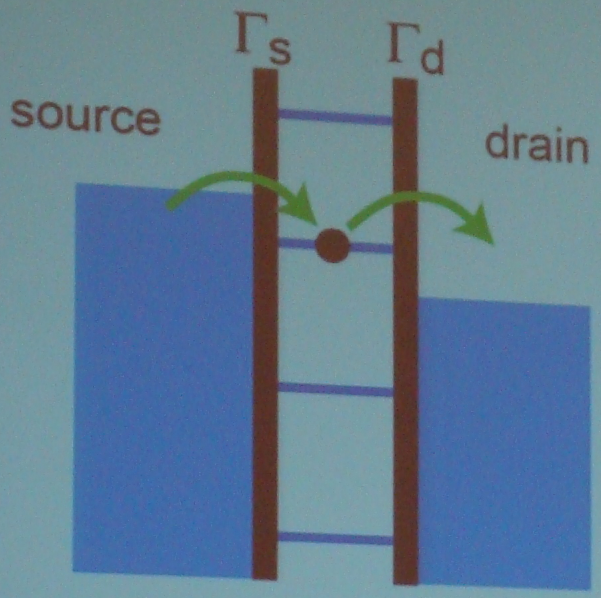




See for example:

- Field *et al.*, PRL **70**, 1311 (1993)
- Buks *et al.*, Nature **391**, 971 (1998)

How and what we count

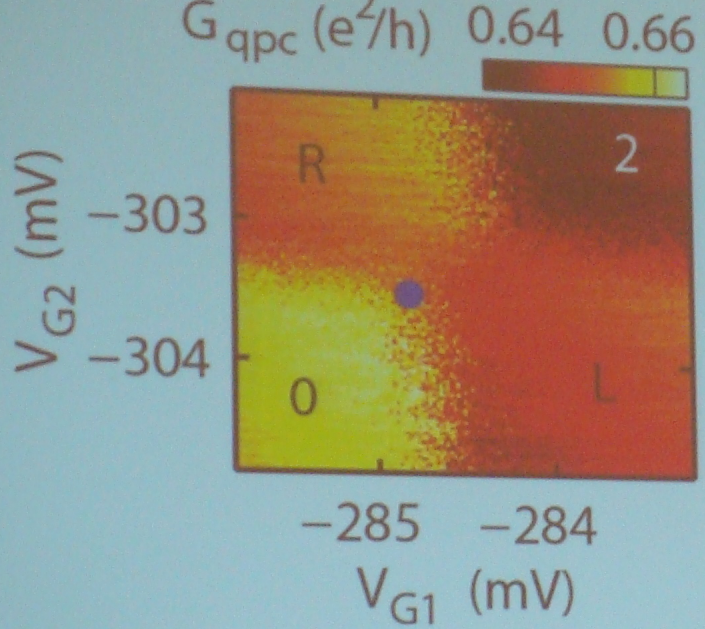


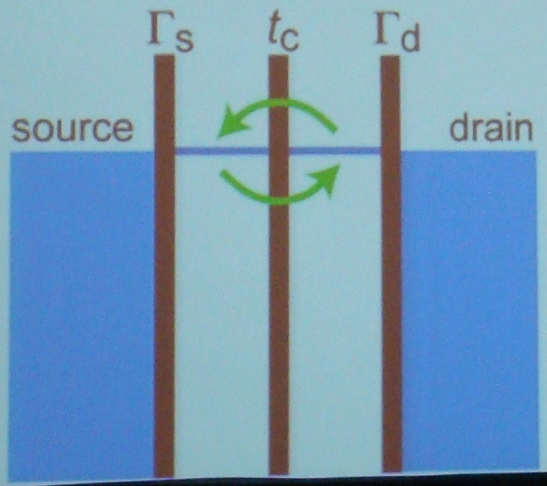
Count: One electron leaves the quantum dot

Number of Counts per time interval: Full counting statistics

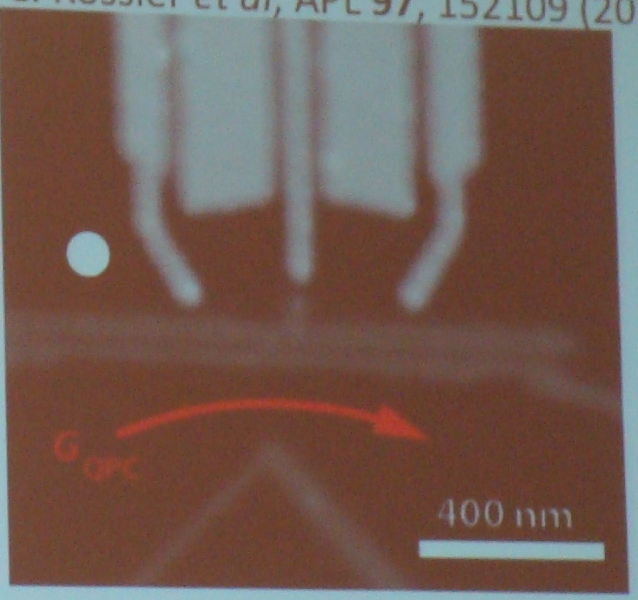
Measurements in the single-level transport regime

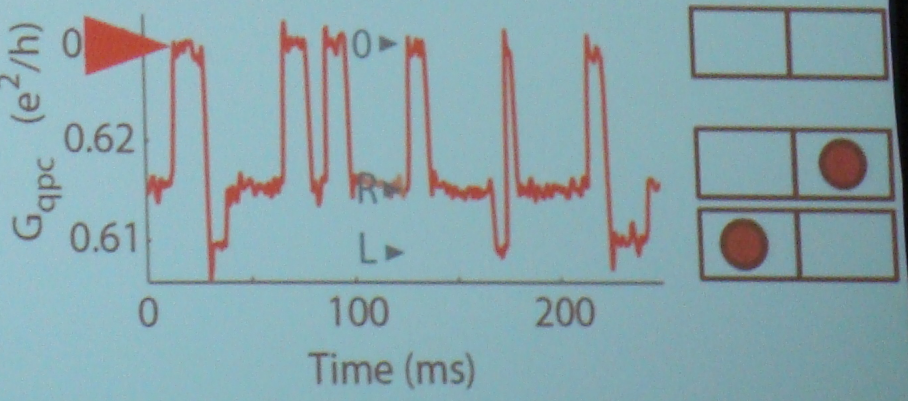
Charge detection in double quantum dots: an implementation





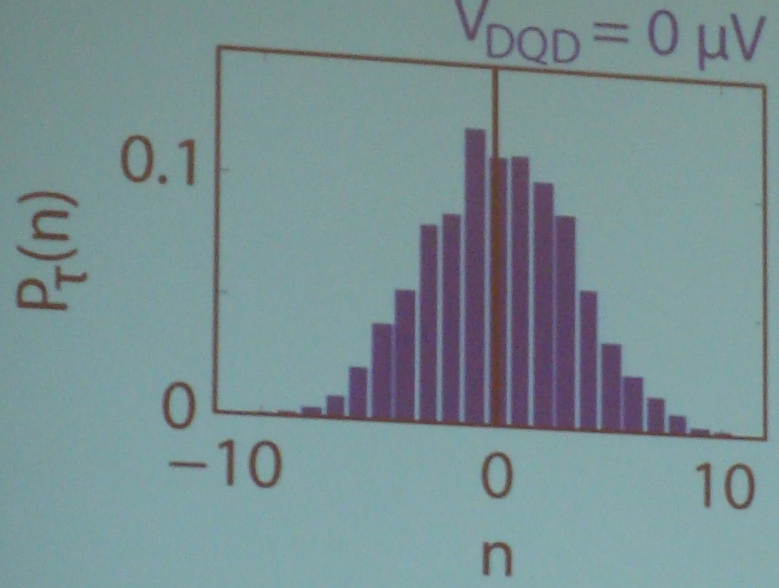
C. Rössler *et al*, APL **97**, 152109 (2010)





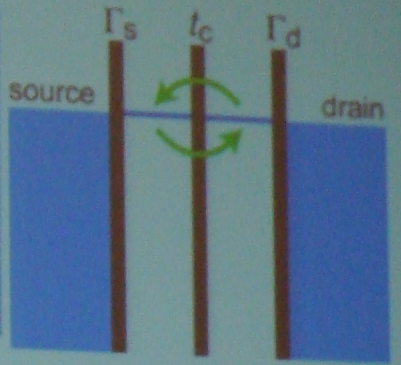
see also: T. Fujisawa *et al*, Science **312**, 5780 (2006)

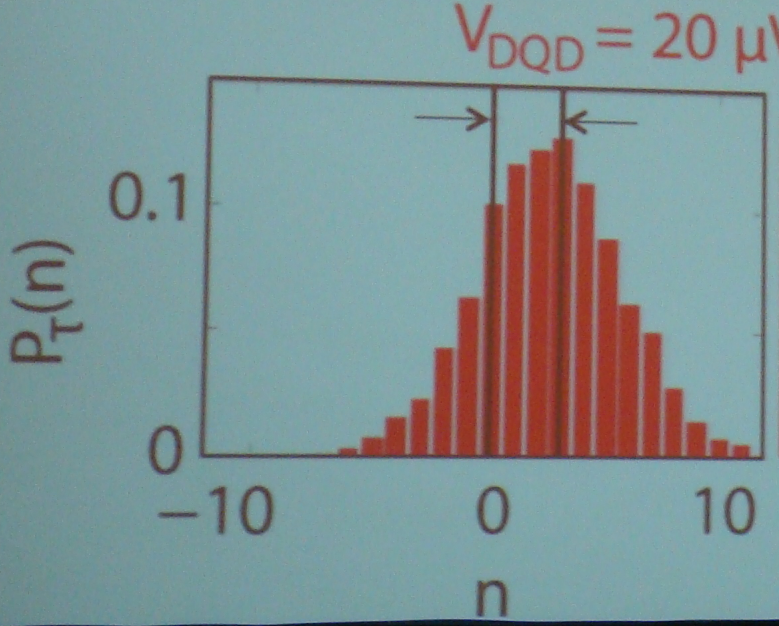
Full counting statistics of the current



$V_{DQD} = 0\ \mu V$
→ no net charge flow

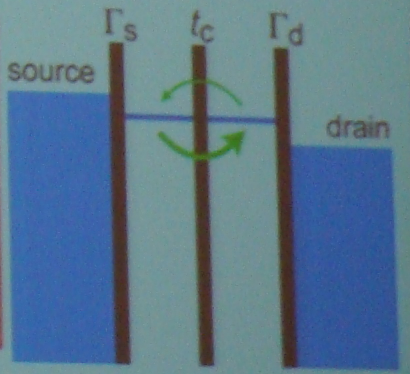
<n> = 0.09 ± 0.09





$V_{DQD} = 20\ \mu V$
→ finite charge flow

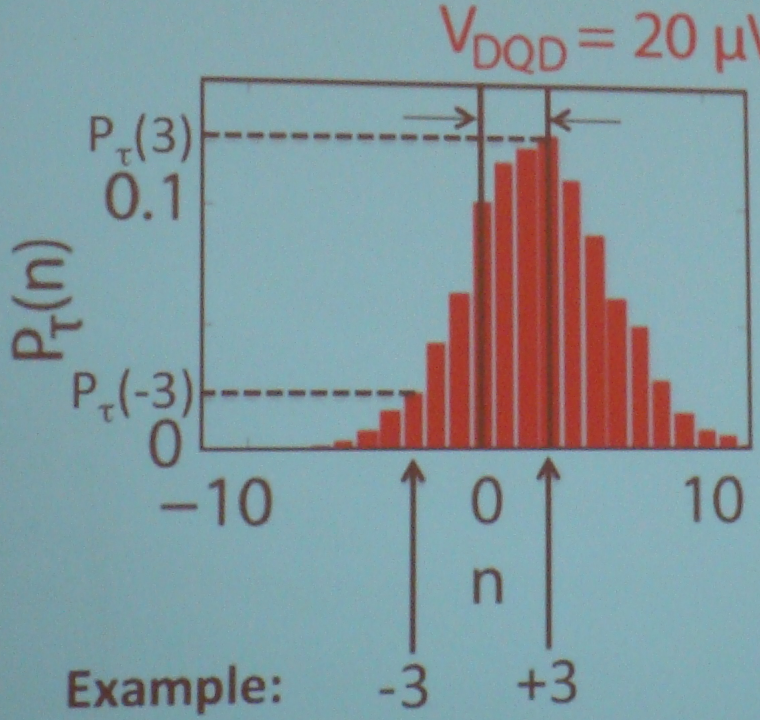
<n> = 2.39 ± 0.09



Fluctuation theorem...

...and full counting statistics

$$\frac{P_\tau(\Delta S)}{P_\tau(-\Delta S)} = \exp\left(\frac{\Delta S}{k_B}\right) \Rightarrow \frac{P_\tau(n)}{P_\tau(-n)} = \exp\left(\frac{neV}{k_B T}\right)$$



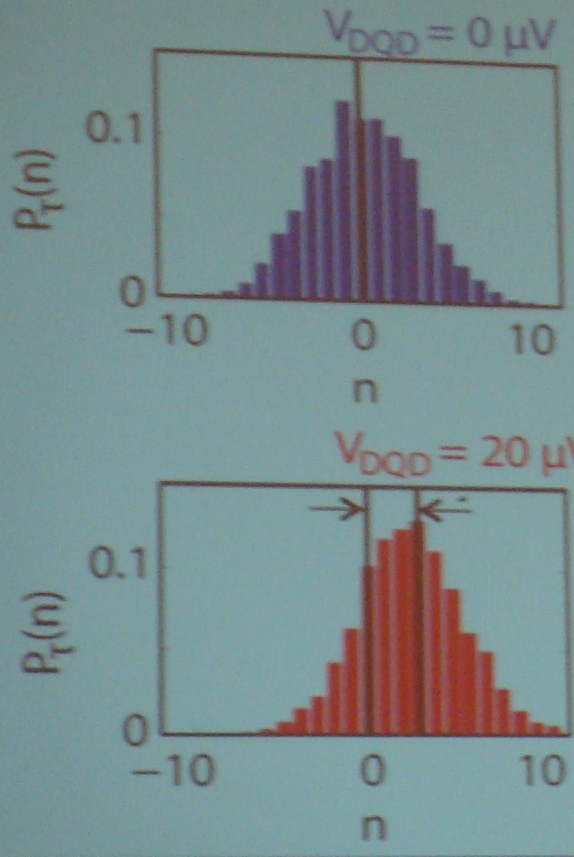
n: number of charges transferred from source to drain

see also: Y. Utsumi *et al*, PRB **81**, 125331 (2010)

Experimental test...

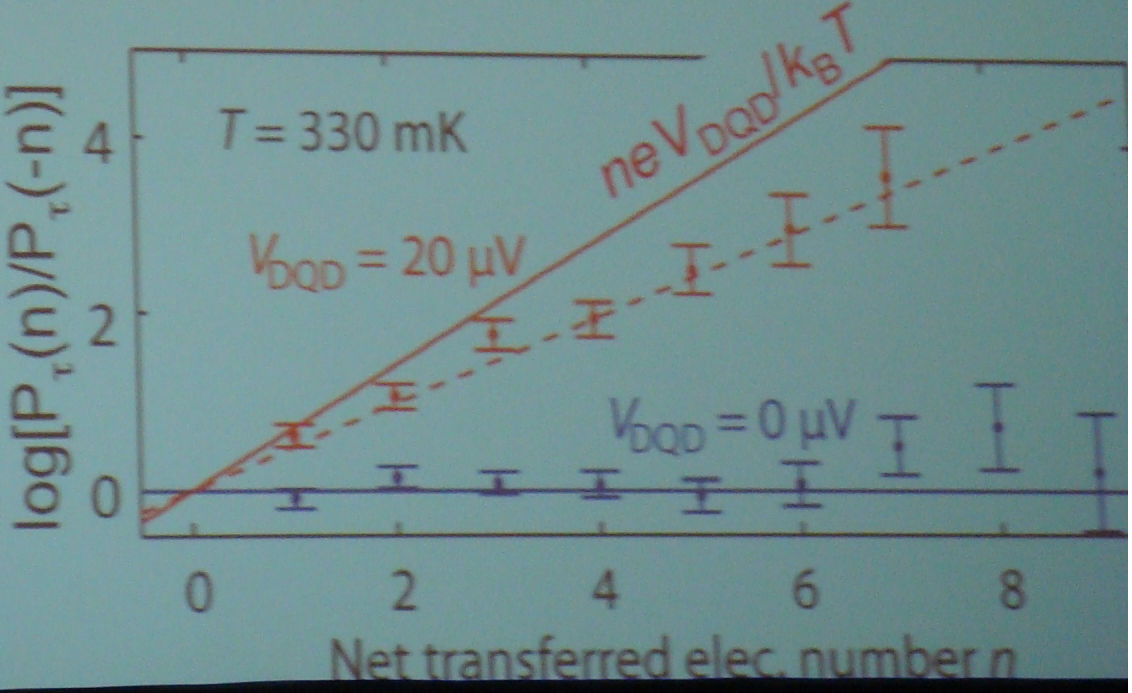
...of the fluctuation theorem

$$\frac{P_\tau(n)}{P_\tau(-n)} = \exp\left(\frac{neV_{\mathrm{DQD}}}{k_{\mathrm{B}}T}\right)$$



slope about 30% smaller than expected from theory (solid line)

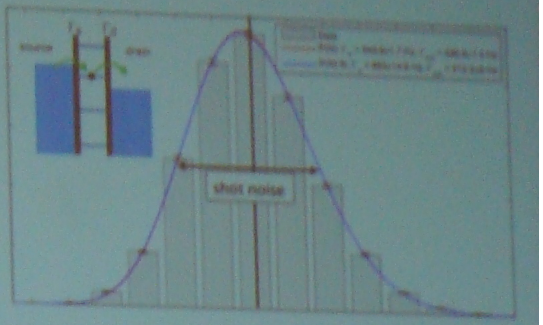
B. Küng et al, PRX **2**, 011001 (2012).



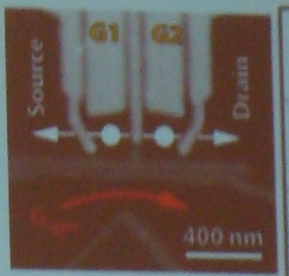
Summary

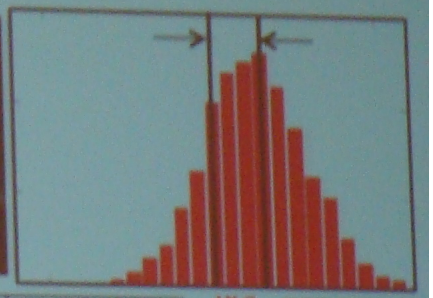
Full counting statistics in single quantum dots

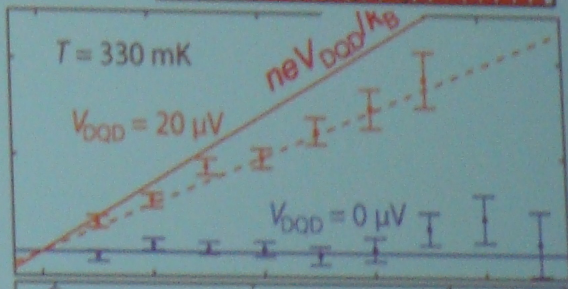
S. Gustavsson *et al*, PRL **96**, 076605 (2006)



Bidirectional electron counting with a DQD

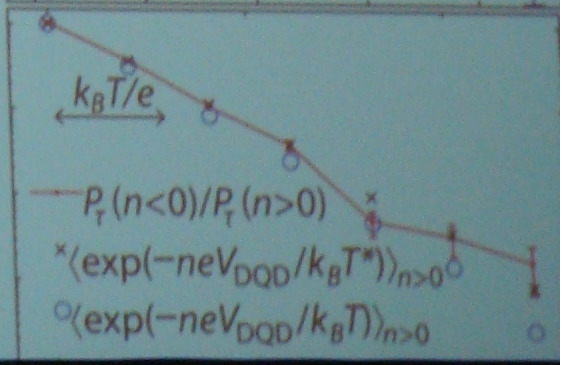






First quantitative test of fluctuation theorem in a mesoscopic conductor

- low and high bias
- different temperatures



B. Küng et al, PRX ***2****, 011001 (2012).*